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ABSTRACT

A traditional discussion of obesity considers the number of pounds over what is considered average for one's age, height, and sex, and is based on the assumption that the average weight for a given group of people of the same age, height, and sex is the healthiest status for that group. There is a physiological and biochemical basis for obesity. Basically, fat has a number of constructive functions in the body: it supplies a reserve source of energy; serves as a medium for fat soluble vitamins; acts as an insulator from cold; and provides support and protection to body organs. However, excess adipose tissue places added strain on the circulatory, respiratory, and renal systems, and body composition is the only valid criterion for determining the state of obesity. The role of exercise and physical activity have been traditionally played down in weight control education, but physiologically these are vital because muscle cells are the most active metabolic cells in the body. Physical educators can play a major role in the furthering of obesity education by including in their curriculum a test of body composition and instilling in their students and future physical educators the idea that obesity control is an individual responsibility. (DMT)

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THE EDUCATIONAL ASPECTS OF OBESITY

David A. Kaufmann

Fat can be defined in two contexts: 1) the biochemical context, i.e., an ester of glycerol combined with a fatty acid or 2) the histological context, i.e., a whitish yellowish tissue of adipose cells that form soft layers within the body.

Basically fat has a number of constructive functions in the body:

1) It supplies the body with a reserve source of energy.
2) It serves as a medium for the fat soluble vitamins.
3) It acts as an insulator from the cold.
4) It provides support and protection to body organs and can improve within limits, the esthetic appearance of one's body.

Although fat tissue does have these beneficial functions for our bodies, it is like the old axiom in life----"too much of anything becomes harmful." Most health and medical authorities agree that obesity predisposes one to illness and premature death from a multitude of secondary causes. Excess adipose tissue places an added strain on the circulatory, respiratory and renal systems. Armstrong et al (1) found that mortality rates were 79% higher for men markedly overweight and 42% higher for men moderately overweight than normal males.

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Obesity Defined

The old arbitrary definition of obesity was defined as X number of pounds over what was considered average for one's age, height and sex and was based on the erroneous assumption that the average weight for a given group of people of the same age, height and sex was the healthiest status for that group.

After some theorizing about arbitrary standards of body builds for people in these groups, body composition was thought to be the most important factor. Wells et al (11) concluded that body weight measures give no indication of tissue composition. Specific gravity or weight per unit volume

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of tissue provides a more accurate index of proper weight through measures of lean and fat tissues. This concept means that our age, height, sex and body build tables are of little value in telling us about the degree of obesity. To illustrate this point, Wilmore (12) reported body composition data collected from a professional football player. This player in a state of training weighed 265 pounds. According to the Metropolitan Life Insurance standards for his age, height and body build, he should have weighed 192 pounds. It was determined in the laboratory that his lean body weight, which is the body weight minus the weight of the fat tissue, was 225 pounds. This finding means that he would have to lose 33 pounds of lean tissue (225 pounds minus 192 pounds)which could be comparable to an arm or leg. To lose functional lean tissue would be quite unwise from the standpoint of good health, but this decision would have to be the recommendation of a physician who absolutely followed the Metropolitan Life standards for obesity. This example depicts how important the concept of body composition is in determining obesity. In fact, body composition is the only valid criterion for determining the state of obesity.

What are the amounts of fat percent that denote a healthy state? Dr. Wilmore has identified 15% fat in males and 22.5% fat in females as a standard level compatible with normal health. These standards are approximately the body composition of a newborn baby (4).

If one knows that a certain amount of fat is essential for the functions outlined earlier (probably between two and six percent of the total body weight) and that an additional amount is allowable, i.e., not deterimental to one's health, the 15% for males and 22.5% for females become reasonable standards. Any significant amount (5%) above these standards would denote obesity.

What happens to one's body composition ratio of fat to lean as one ages? Table 1 presents data on 173 adult males at Fitzsimons General

Table I

Body Density and Percentage of Fat in Adult Males, Fitzsimons General Hospital

Age Group	n	Body Weight (kg)	Density (g/ml)	Fat (%)
17-19	9	71.9 ± 14.4	1.060 ± 0.0.1	19.6 ± 7.0
20-24	35	73.6 ± 7.5	1.060 ± 0.013	19.5 ± 5.5
25-29	29	76.8 ± 14.0	1.053 ± 0.017	22.6 ± 7.3
30-34	15	85.8 ± 17.6	1.044 ± 0.013	26.3 ± 6.1
35-39	13	76.2 ± 10.6	1.043 ± 0.012	26.9 ± 3.6
40-44	25	75.4 ± 11.1	1.042 ± 0.012	27.1 ± 5.5
45-49	24	76.2 ± 10.0	1.038 ± 0.010	29.3 ± 4.5
50-54	12	75.5 ± 10.1	1.032 ± 0.026	32.8 ± 9.1
55-59	4	79.0 ± 10.3	1.031 ± 0.021	32.5 ± 4.8
60-64	5	79.7 ± 7.5	1.026 ± 0.010	34.7 ± 4.5
65-69	2	68.6 ± 2.1	1.017 ± 0.001	38.7 ± 0.6
TOTAL	173			

*From Body Composition in Animals and Man

Proceedings of Symposium May 4, 5, 6, 1967,
University of Missouri, Columbia
Washington, D.C.: National Academy of Sciences
Publication N. 1598-1968, P. 498

Hospital. As one can clearly see, the percent of fat in males tends to increase with age.

Another important question is, what changes take place in the fat cell when one becomes fat? Figure 1 portrays the evolution of a primitive fat cell to an obese state. The primitive fat cell is irregularly shaped, has a central nucleus and a large amount of cytoplasm surrounding the nucleus.

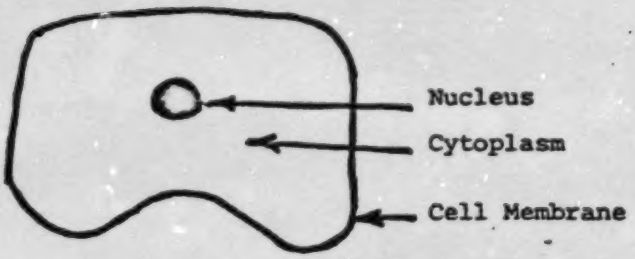
In stage 1 fat droplets appear interspersed in the cytoplasm. The fat droplets increase in size in stage 2. In the final stage the fat droplets become immense and finally merge into one giant droplet pushing the nucleus to the top of the cell.

The nucleus is usually crescent shaped, but as the giant fat droplet enlarges, the nucleus is pushed to the top of the cell, and the cytoplasm is pressed to the periphery where it forms a thin layer around the fat droplet. The fat cell has become bloated with fat substance. In plain language the fat cell has become FAT!! This same process is exactly what happens when a person becomes obese. He increases his percent of fat by storing more and more fat substance in his fat cells.

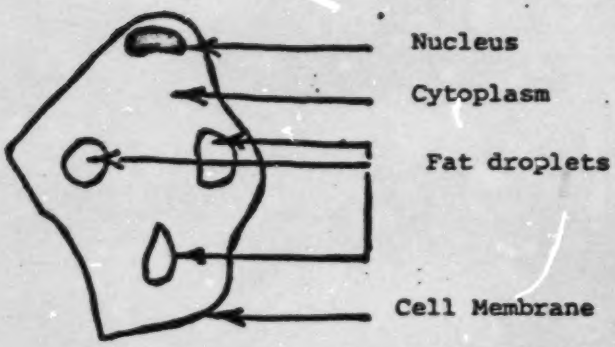
But what about the total number of fat cells in the human body? Does the number of fat cells increase as one grows? Does the number of fat cells increase in a mature adult when he or she becomes obese? Oscai (10) recently reported that at about age 20 the number of fat cells in the normal human body stabilizes and tends to remain constant throughout life. Fat cells are not easily destroyed. They have the ability to persist with little or no fat within their membranous boundaries. When a person loses weight, there is a decrease in the amount of fat substance within the fat cell, while the number of fat cells remains approximately the same. In other words, fat cells become thin! As yet, there is no evidence that fat cells can be destroyed in a healthy body.

What then determines the number of adipose cells in an individual body?

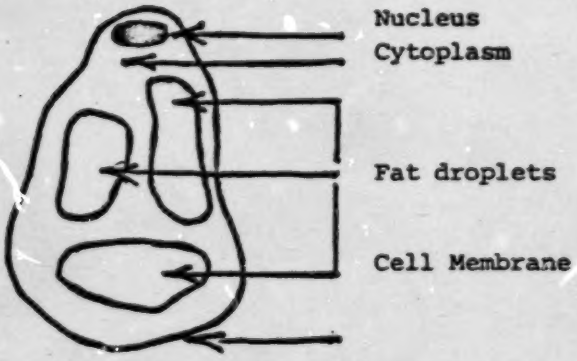
Primitive Fat Cell



Stage 1



Stage 2



Saturated Fat Cell

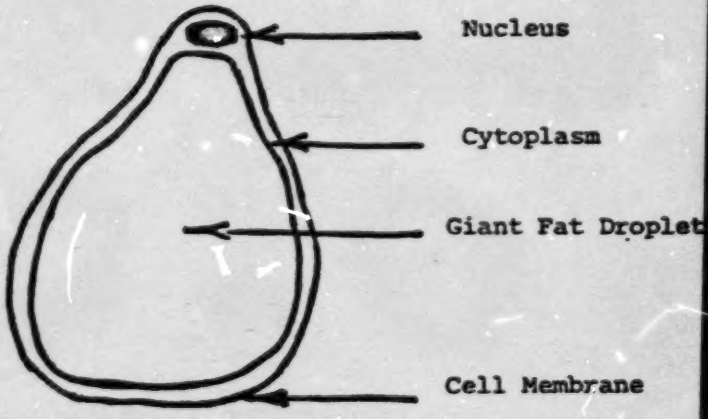


Figure 1
Evolution of Typical Fat Cell
(Author's drawings taken from Figure 11-17, Histology
by Arthur W. Ham, Philadelphia: J.B. Lippincott Co.,

It is postulated that this number is primarily controlled by one's heredity with some limited influence from external factors. Dr. Oscai has reported (10) that there is some evidence to indicate that habitual, vigorous exercise inhibits the increase of adipose cell division in the growing individual. He claims that hypercellularity in youth will provide the individual with too many fat cells during adult life. These numerous fat cells continually yearn to absorb fat substance. When a person loses weight, he or she decreases their storage of fat substance in their adipose cells. However, these same adipose cells in time urge him or her to replenish themselves with fat, and there is a natural tendency to regain adipose weight that was lost.

What are the genetic probabilities of one being fat? Orduna (9) claimed, "Children without obese parents have about a 10 percent chance of becoming fat; if one parent is obese the chance is 40 percent, and it reaches 80 percent for children of two obese parents." Also, there is strong evidence that if an individual is obese as a child, he has a 90 percent chance of being obese as an adult. The old adage, "a fat child is a healthy child," is a bunch of nonsense! Actually, an obese child is probably going to become an unhealthy adult from the aspect of proper body composition.

Economic Charlatans

It is estimated that there are about 60 million obese people in the United States and that between 10 and 20 million of them are involved in dieting or in activities that promise a reduction of their excess adiposity. We are all familiar with published advertisements like, "Enjoy Losing up to 12 Pounds of Ugly Fat in 14 Days" and "Do You Like the Shape You're In? If Your Figure Is Not Becoming to You.....You Should Be Coming to Us!

Use Slender Wrap to Lose Two Dress Sizes in One Month." These types of advertisements make impossible claims. What obese person does not want to lose 12 pounds in 14 days or lose two dress sizes within a month's time??? They are emotional appeals by economic imperialists to the wishful thinking of overweight people. Health and physical educators must do all they can to expose the anti-scientific and anti-common sense of these "pie-in-the-sky" promises.

Fallacies About Fat

There are three major fallacies concerning obesity.

1. For many years the medical scientists thought that the role of exercise in weight control was minimal. Mayer (7) has pointed out that physical inactivity is a primary factor for explaining the increasing frequency of obesity in modern western countries. He (8) also indicated that obese girls ate less than non-obese girls. This finding is astounding as it is popularly thought that obese people are overweight, because they eat more than people of normal weight. Actually, obesity can often be traced to a lack of regular physical activity without an abnormal increase in caloric intake. This recent discovery somewhat upsets the diet emphasizers who attack the problem from only one angle. We now know that regular, vigorous exercise combined with sensible dietary regulation is the most desirable approach to the reduction of excess fat tissue.
2. Another fallacy is the belief that regular, vigorous exercise provides relatively insignificant caloric expenditure. If one just looks at the caloric costs of

various types of work-styles, the falseness of this statement is clear. For example, the daily caloric projections for men used by the National Research Council range from 2,400 calories for sedentary men to 4,500 calories for very active men. Heavy laborers, combat soldiers and athletes in training are estimated to use up to 6,000 calories in a work day. Certainly, the magnitude of daily activity, which can more than double daily energy expenditure, should not be ruled out as an unimportant factor in determining one's net caloric balance! The old wive's tale that it is futile to expect regular exercise to act as a reducing aid is still quite popular. We continue to hear statements such as, "One has to walk for 36 hours, split wood for seven hours or play volleyball for 10 hours to burn up the caloric equivalent of one pound of fat." Yet, the caloric expenditure caused by vigorous activity occurs whether the physical activity is performed in a day or a year. If jogging for a half-hour was a daily practice, it would be, according to the detractors of vigorous activity, equivalent to burning approximately 26 pounds of fat a year. Similarly, one-half hour a day of handball or racketball would cause approximately 16 pounds of fat to disappear during the same period. The effect of habitual caloric expenditure through physical activity is cumulative. If one does not exercise regularly, he or she is theoretically predisposing himself or herself to the acquisition of excess fat tissue. If we desire to avoid this situation, we must either make vigorous exercise a daily habit, or feel hungrey all

our lives. Discounting the value of playing ten games of tennis, because in terms of caloric cost, it is approximately equivalent to only a slice of apple pie a la mode is all the more dangerous, because not only may the person so advised not play tennis, but may also eat the pie a la mode!!!

3. A third fallacy is the ignorance of the value of weight training for energy expenditure and weight control. We all know that a regular, progressive weight training program can increase the amount of muscle mass in an individual. Muscle cells are one of the most active metabolic cells in the body. Fat tissue does not use as many calories as muscle cells at rest. Keys (5) et al have demonstrated that the decreased expenditure of calories during resting metabolism in different age groups was related to smaller amounts of muscle mass in the individuals and not related to age. Lamb (6) also reported the case of a subject who at age 26 used 67 calories/hour at rest, and at age 76 used only 52 calories/hour while at rest. Since it takes 60 calories more to walk a mile rather than to sit at rest, it follows that this man would have to walk six miles a day at age 76 in order to use the same number of calories that he would have expended by sitting at rest all day at age 26. This is basically what happens to many people who do not maintain a sufficient amount of muscle mass. As we age we need to burn more calories through exercise in order to prevent obesity. The problem can be partially solved by following a regular weight training program to maintain muscle mass. There must be a certain trade-off between

strength and endurance exercises. With an adequate muscle building and maintenance training program the aging individual won't need to jog or swim as much in order to burn the necessary calories and, thus, avoid excess gain of fat tissue. If one maintains the proper amount of muscle mass, the body will naturally burn the calories at rest that would normally accumulate if there was a steady decrease in the amount of muscle mass that occurs with age.

What Can Health and Physical Educators Do?

There is plenty that we can do. First, we must make sure that we ourselves are not obese. We all know that actions speak louder than words. We teach more by what we do than by what we say. Furthermore, talk is often very cheap. Education is sometimes defined as "a change in behavior." How can we change our students' behavior toward positive action if we cannot change our own? We must practice what we preach. We must "walk, the way we talk." This is the most desirable method of changing behavior of others.

This idea raises the question, should an obese student be allowed to enter and graduate in a health and physical education major program? Granted some of these students have abilities and talents needed for effective teaching, but research (2) has indicated that obesity contributes to "esthetic disfigurement, organic disorders, social rejection, psychological maladjustments and emotional problems." Aside from the visual advertisement of their own overweight condition, should we gamble on certifying students for the teaching profession who have a high probability of having these disadvantages? These questions are important considerations that each professional department for the preparation of health and physical

educators should seriously consider.

Second, we must include a test of body composition in all health fitness or physical fitness batteries. To test only for traits that indicate athletic prowess and to omit testing traits, like body composition, that are also directly related to health and physical fitness, involve errors of great magnitude. According to Clarke (2), the skinfold caliper* test used on a vertical fold at mid-triceps level is considered the best measure for estimating obesity. He (2) also published some norms for determining minimum triceps thickness that may indicate obesity. Corbin (3) also published triceps skinfold standards for boys and girls. These standards (3) are reprinted in tables 2 and 3 in order to provide teachers with some norms for school-age children.

Third, we must do a better job of selling the idea that health is a personal responsibility, and that it is unwise to rely solely on the medical-health industry. No physician can give instant health to anyone, and no physician can make individuals practice good health habits. Good health practices are entirely up to the individual. However, every health and physical educator must be a salesman. We must sell our product - adequate exercise, rest and nutrition - to achieve our goal, the optimal health for the individual. Regarding obesity, a common disease of modern western civilization, we must literally attack the factors that result in our sedentary way of life: the of overuse of the automobile, television, and modern appliances and our excess ingestion of food. We must push the best alternative to these factors, regular vigorous physical activity, as a preventative measure against obesity. Once again, we must practice what we preach. We must exercise daily to expend those calories so that they do not result in accumulated fat, and so that we do not set a negative example for the people with whom we come in contact. It is the responsibility

*Lange Skinfold Caliper, PC 5028, J.A. Preston Corporation, 71 5th Avenue, New York, N.Y., 10003, Price $67.50.

of every individual to control his or her own weight. It is our responsibility to make them aware of their responsibility.

TABLE 2*

Triceps skin-fold standards for boys

Skin fold thickness, mm	Percentiles **							Skin-fold thickness, mm
	6 Years	7 Years	8 Years	9 Years	10 Years	11 Years	12 Years	
4	10.71	3.03	4.35	1.20	6.25	4.31	4.08	4
5		10.10	10.44	7.22	10.71	9.69	12.24	5
6	28.57	20.20	20.87	15.65	23.21	22.59	16.32	6
7	50.00	40.40	28.70	32.52	36.60	38.72	26.52	7
8	57.14	52.52	44.35	49.39	44.64	46.25	30.60	8
9	71.43	65.65	54.78	57.82	51.78	55.93	38.76	9
10	82.14	75.75	61.74	63.84	60.71	59.16	46.92	10
11		87.87	66.96	66.25	68.75	61.31	53.04	11
12	(85.71)	90.90	74.79	72.27	72.32	65.61	63.24	12
13	(92.85)	(94.94)	83.49	80.70	75.89	70.99	73.44	13
14	(99.99)	(95.95)	(85.23)	81.90	82.14	75.29	75.48	14
15		(96.96)		(84.31)	83.93	80.67	79.56	15
16		(97.97)	(86.97)	(89.13)	(87.50)	82.82		16
17			(87.84)	(90.33)				17
18			(89.58)	(91.53)	(89.29)	(84.97)	(83.64)	18
19		(98.98)	(92.19)	(92.73)	(90.18)	(87.12)		19
20			(93.93)	(93.93)	(91.97)	(89.27)	(85.68)	20
21			(94.80)	(96.34)	(93.76)	(90.35)	(89.76)	21
22			(95.67)	(97.54)	(94.65)			22
23			(97.41)		(96.44)	(91.43)	(93.84)	23
24			(98.28)		(97.33)		(95.88)	24
25					(98.22)	(94.66)		25
26				(99.95)		(96.81)		26
27					(99.11)			27
28		(99.99)	(99.15)				(97.92)	28
29						(97.89)		29
30			(100.02)		(100.00)			30
31								31
32								32
33								33
34						(98.97)	(99.96)	34
35								35
36						(100.05)		36
N=	28	99	115	83	112	93	59	

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**Percentiles in parentheses indicate children who are classified as obese.

TABLE 3*

Triceps skin-fold standards for girls

Skin-fold thickness, mm	Percentiles **							Skin-fold thickness, mm
	6 Years	7 Years	8 Years	9 Years	10 Years	11 Years	12 Years	
4		2.83	1.06	0.93	1.10			4
5		7.55	2.12	2 80	3.30	6.86		5
6	12.50	10.38	6.38	6.54		11.76	12.82	6
7	22.50	17.93	14.89	8.41	7.70	17.64	25.64	7
8	30.00	30.19	22.34	20.56	14.29	21.56	30.77	8
9	42.50	37.74	28.72	33.64	18.69	26.46	38.46	9
10	50.00	56.61	38.29	45.79	25.28	29.40	51.28	10
11	65.00	63.21	46.80	51.40	29.68	35.28		11
12	75.00	70.76	52.12	61.68	43.97	43.12	56.41	12
13	82.50	76.42	58.50	63.55	51.66	50.96	64.10	13
14	85.00	82.08	65.95	67.29	54.96	57.82	69.23	14
15	(90.00)	87.74	71.27	74.77	59.36	61.74	74.36	15
16	(92.50)	(91.51)	72.33	78.51	63.76	66.64	79.49	16
17	(100.00)	(93.40)	(76.59)	83.18	64.86	68.60	82.05	17
18		(95.29)	(80.85)	(84.11)	69.26	73.50		18
19		(96.23)	(86.17)	(85.98)	72.56	77.42	84.61	19
20		(97.17)	(91.49)	(89.72)	(74.76)		(87.17)	20
21		(98.11)	(93.62)		(79.16)	(82.32)		21
22					(83.56)	(83.30)		22
23		(99.05)		(90.65)	(84.66)	(85.26)		23
24		(99.99)	(94.68)	(92.52)	(85.76)	(89.18)	(89.73)	24
25			(97.87)	(93.45)	(87.96)			25
26			(100.00)	(94.38)	(91.26)	(91.14)		26
27				(96.25)	(92.36)	(92.12)	(92.29)	27
28				(97.18)	(94.56)	(96.04)	(94.85)	28
29						(98.00)		29
30				(98.11)	(95.66)			30
31					(96.76)			31
32				(99.98)				32
33								33
34					(98.96)			34
35						(98.98)	(99.98)	35
n	40	106	94	107	91	102	49	

*Reprinted with permission of Am. J. Clin. Nutr. 22: 838, 1969.

**Percentiles in parentheses indicate children who are classified as obese.

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